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# Unirrigated Cotton in Southern Russia and the Danubian Countries

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**The introduction of cotton into the Danubian countries and southern-European Russia is an instance of the penetration of a crop beyond the line generally believed to be its limit. As in all such cases, it is difficult to foresee to what degree the plant will accommodate itself to new surroundings; and, if the crop fails to adapt itself fully, what amount of protection it will need, and whether the countries involved will be willing to make the necessary sacrifices to protect it permanently.**

Cotton, like all other plants, has reasonably well delimited northern and southern border lines beyond which penetration is not practicable. Each such delimitation is, however, valid only for a given time. Virtually every important plant of the Temperate Zone had its original home in a warm, if not in a tropical, climate and has gradually moved, or been moved by human genius, into a more temperate, or even a cool, environment. Corn, one of North America's principal crops, traveled all the way from Central America through the whole of the United States and into Canada. Rice is another example of an important tropical plant which has penetrated well into the Temperate Zone. In this move away from the Tropics, the plants mostly change their habits more or less substantially. Shortening of the growing season is the most common form of such accommodation to the changed environment.

For every case of a successful move of a plant beyond the line which had previously been commonly believed to be its northern limit, there usually are many cases of unsuccessful attempts to effect such a move. Yet every such case has to be carefully scrutinized. It may develop that the plant has made further changes which adapted it to conditions unsuitable for it only a short time before. Or the demand for the plant, or its fruit, may have changed to such an extent as to permit the growing of the plant in the less favorable environment. Such change in demand may be natural, or it may be created artificially by protective tariffs, premiums, and the like. To foresee the future of a plant in its new place of production, it is often not enough merely to determine that the plant cannot be grown without protection. The degree of its unadaptability and, consequently, of the needed protection may also have to be known.

The relatively recent penetration of cotton into the Danubian countries, and especially into southern-European Russia, is a phenomenon of the described type. All those areas lie beyond the line which is commonly believed to be the limit of northern penetration of this plant; most of them lie considerably beyond that line. It seems certain that, while serious efforts have been made to improve the cotton plant's adaptability to the natural conditions of those areas, thus far the changes have not been sufficient to make it even fairly well adapted to most of them. The growing of cotton in those areas was made possible by a great deal of protection. It seems, moreover, likely that the changes in the cotton plant which may be attained in the near future will result in curtailing the amount rather than in eliminating the need for protection.

## History

Attempts to grow cotton in the Danubian countries and southern Russia were repeatedly made in the past, but, at best, as in the more favorable parts of Bulgaria, the attained scale of production was very small. In the other countries here discussed all efforts proved a practical failure until the second decade of the present century.[1]

Bulgaria, the southernmost among the Danubian countries, was the first to start growing cotton but only on a very small scale. Before World War I, it had about 3,000 acres in this crop. Gradually increasing, the cotton acreage exceeded 10,000 acres in 1927 and 20,000 acres in 1932. Expanding at a more rapid rate later on, the area occupied by cotton reached 140,000 acres in 1938. It declined during the war to around 50,000 in 1944 but has since partly recovered.

Yugoslavia had 1,500 acres in cotton in 1920. Expanding very slowly, the cotton acreage

*Office of Foreign Agricultural Relations.

[1] On such efforts in Russia, see Alexander Melkich (*12, pp. 74–75*). Italic numbers in parentheses refer to Literature Cited, p. 13.

reached about 5,000 acres in 1936 and 14,000 in 1939. In 1945 it amounted to around 10,000 acres.

Rumania began to grow cotton only in 1930, later even than southern-European Russia. The cotton acreage amounted to about 4,000 acres in 1937. At a much accelerated rate, it reached 10,000 acres in 1939, 75,000 in 1943, and exceeded 125,000 acres in 1945, in spite of the loss of part of the principal producing area to Bulgaria.

Hungary thus far has not gone beyond isolated attempts on the smallest scale.

Developments in the Danubian countries were overshadowed by the progress of cotton in southern-European Russia (fig. 1). Here cotton was first statistically registered in 1928 with an acreage of close to 6,000 acres. In 1932 there were over 1,000,000 acres in this crop. After a temporary setback in 1933 and 1934, the acreage in unirrigated cotton reached almost 2 million acres in 1935 and later remained at the level of about 1.5 million acres until Russia's entrance into the war.

The cotton area in southern Russia was almost entirely overrun by the Germans during the war, and cotton growing was practically discontinued. The Fourth Five-Year Plan sets 416,000 acres as the goal for unirrigated cotton in 1950.

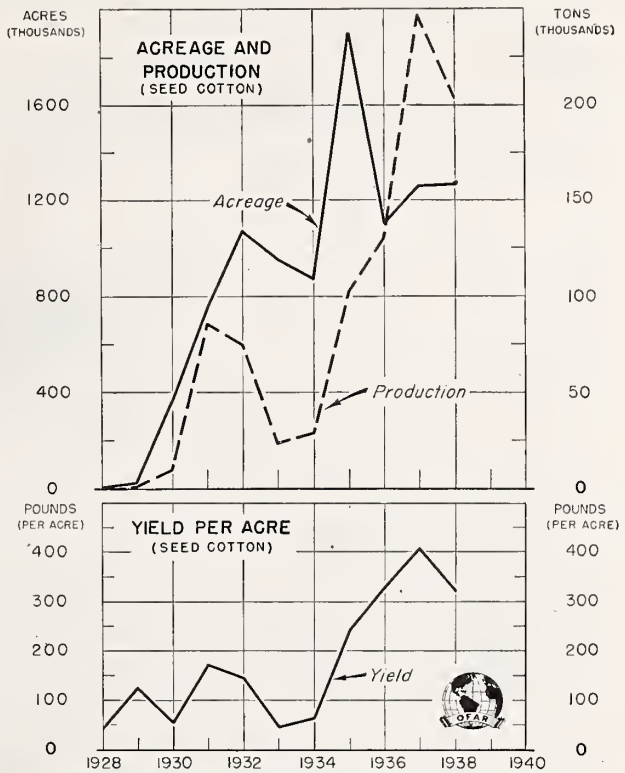


FIGURE 1.—Acreage, yield, and production of unirrigated cotton in the Soviet Union.

## Producing Areas

Most of the cotton in Bulgaria is grown in the south, mainly in the Maritsa Valley in the southeast (fig. 2);[2] Haskovo, Chirpan, Harmanli, Stara Zagora, and Svilengrad are the most important cotton-growing counties. A small-scale cotton area is found in the southwestern tip of the country in the Struma Valley (the counties of Petrich and Sveti Vrach). On a small scale, cotton is also grown in northern Bulgaria along the Danube River.

All Yugoslav cotton is grown in the southernmost part of the country, in the Vardar Valley (counties of Doiran, Djevada, Negotin), and in the Strumitsa Valley (county of Strumitsa). Cotton production in both the Vardar and Struma Valleys of Yugoslavia and Bulgaria continues beyond the borders of these countries into Greece.

The lowlands of the Danube River and the Dobruja are the principal cotton areas of Rumania. The five consecutive counties stretching from west to east—Teleorman, Vlasca, Ilfov, Ialomita, and Constanta—together had, in 1945, 130,000 acres from an estimated total of 136,000. Southern Dobruja has been under Bulgarian control since 1940.

The Ukraine, including the Crimea, is most important among the new cotton areas of Soviet Russia and accounted for 55 percent of the total acreage of those areas in 1938. In the Ukraine, cotton is grown in the southernmost part, that is, in the vicinity of the Black Sea, mainly in the western portion of this strip. Nikolaev Oblast (Province) had more than half the Ukrainian cotton acreage in 1938 and Dnepropetrovsk almost all the remainder. Second in importance is the eastern half of the strip stretching north of the Caucasus (Ordjonikidze Krai [Province], the since-liquidated Checheno-Ingush, and Dagestan). Third comes the western half of the same strip (Krasnodar, especially the Peninsula Taman between the Black and Azov Seas). Rostov Oblast and the somewhat isolated Stalingrad Oblast are the least important.

[2] The Russian data in fig. 2 are for 1936 and are fairly representative of the extent of the growing of unirrigated cotton in that country before the last war. The data for Yugoslavia and Rumania are for 1939. Bulgarian data are unfortunately for 1936; the acreage was considerably expanded in that country in succeeding years. The expansion in Rumania after 1939 was, however, still larger.

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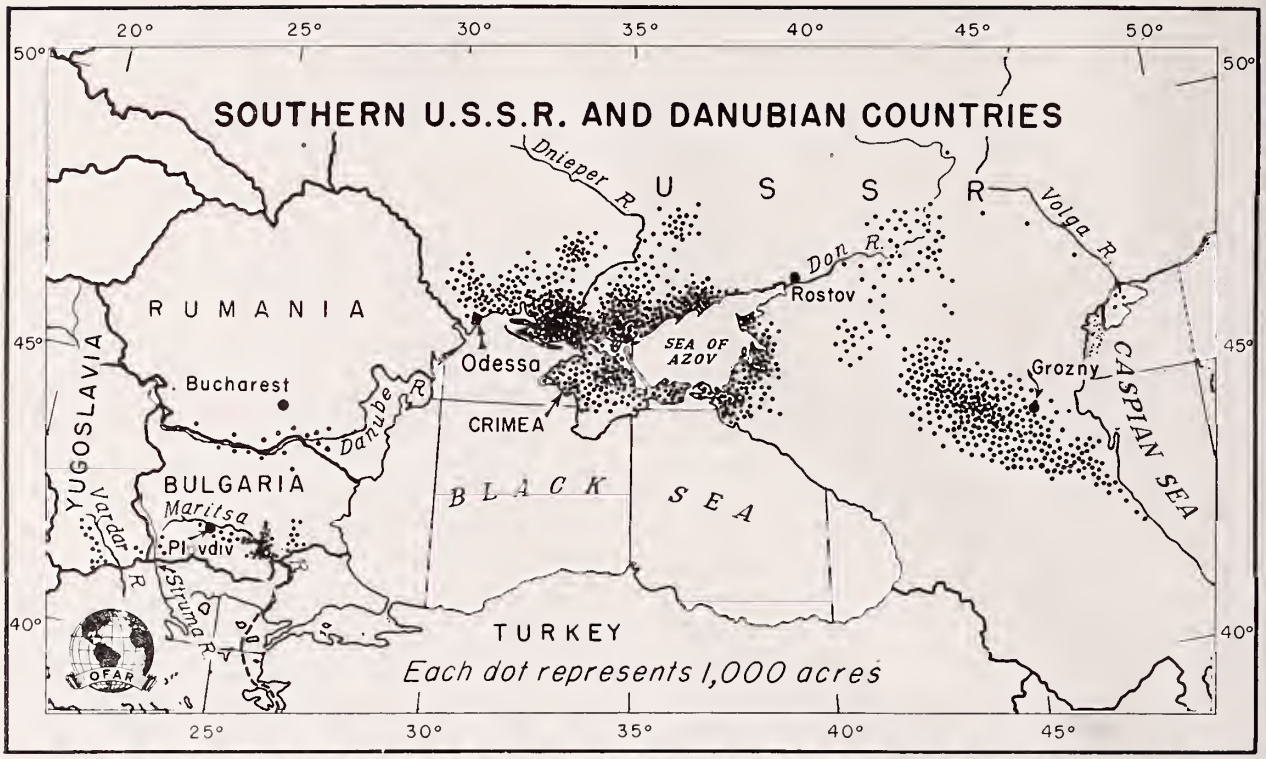


FIGURE 2.—Distribution of unirrigated cotton acreage in southern U. S. S. R. and the Danubian countries.

Cotton reaches latitude 47° N. in the new areas of Russia—the northernmost penetration of cotton in the world—and the Russians are proud of this.

As one may observe from the preceding description, river valleys have a large share in the cotton growing of the Danubian countries. In the first place, this is because they are lowlands and therefore the warmest spots of a given region. The alluvial soils of these valleys prove adapted to cotton also mainly because they are warm. The greater humidity of the valleys also seems to be important. The Russian southern steppe is a lowland—the only significant factor, since warmth is an even more decisive limiting factor for cotton growing here than in the Danubian countries.

## Soil

Cotton can be grown in practically all kinds of soil. Heavy soils, however, are excluded in the areas here analyzed because of their coldness. It takes a heavy soil longer than a light soil to reach the high temperature (about 60° F.) needed for the germination of the cotton seed, and thus the season for growing the plant, too short anyway, is further curtailed.

Since the areas analyzed here are marginal or near-marginal in moisture, very light soil is also unadapted to cotton. Light soils are little adapted also to other crops, but some of these crops require only small inputs of labor, and a failure, due to lack of moisture, means only a small loss.

The alluvial soils largely used for cotton in the Danubian countries are mostly intermediate between heavy and light. In southern Russia most of the cotton is grown on the Chestnut soils predominating there. They contain much smaller quantities of humus and, consequently, fertility than do the typical Chernozem (Black) soils farther north. But they are also lighter and warmer than the latter, and these factors make them adapted to growing cotton.

## Moisture

Textbooks still frequently carry the statement that cotton needs plenty of moisture. This is because most of the world's cotton is grown in areas having either large amounts of precipitation, as eastern United States and China, or artificial irrigation, as Egypt, western United States, and Soviet Central Asia. But the experience of the last decades with cotton in Texas and Oklahoma

has proved conclusively that cotton can be grown with small amounts of moisture. In those States cotton has reached the isohyet of 20 inches of annual precipitation (fig. 3). Cotton indeed displays features of a genuine drought-resistant crop; its development stops or declines when moisture is inadequate and advances again when the moisture supply is replenished. The Texas Experiment Station (*9, p. 17*) summarizes its findings:

> . . . The ability of cotton to withstand hot, dry summers has been recognized but it has not been placed in the category of dry-land crops. That it can safely be so placed is evidenced by comparative yields here and that cotton can well take its place as a drouth-resistant crop alongside of the sorghums, which are recognized as being the premier drouth-resistant crops adapted to dry-land agriculture, is clearly shown.

Like other crops, cotton does not yield so well with inadequate as with adequate precipitation, and very low yields, or complete failures, are a great obstacle in the case of such a crop as cotton, which requires a large amount of work for its successful development. For this reason cotton in the United States does not go so far west as sorghum.

The principal Bulgarian cotton areas have an annual precipitation of from 21 to 24 inches, favorably distributed over the season for this crop. It is the opinion of experts (*8, p. 499*) that, except for rare dry years, the moisture supply is adequate for cotton if care is taken by appropriate cultural practices to prevent waste of moisture. In Rumania, most of the cotton is likewise grown with an annual precipitation of 20 to 24 inches, but parts of the cotton areas receive somewhat less.

The new Russian cotton areas are drier than all the others. Most of them have an annual precipitation of less than 16 inches. The southernmost strip of the Ukraine, part of the Crimea, the Temryuk rayon (district) of Krasnodar Oblast, and the Stalingrad cotton area receive 14 inches or less. As in the other areas here analyzed, the seasonal precipitation in the new Russian cotton areas is in general favorable for cotton, but large variations occur in both total annual precipitation and in its seasonal distribution from year to year.

Owing to lower temperatures, the moisture deficiency in the cotton-growing areas of southern Russia is not so large, compared with the westernmost cotton areas of Oklahoma and Texas, as is indicated by a comparison of the precipitation data. Still, even the effective moisture there is materially less.

Cotton reaches maturity even with a precipitation as small as that received by it in southern Russia, but the yields are necessarily very small, especially in years of subnormal precipitation. N. Rogozhin and I. Kupriyanov (*22, pp. 60–62*) wrote in 1931:

> A negative factor in all new cotton areas is that droughts are frequent and common. The frequently dry August brings about a large loss of buds almost every year. 1930 was such an unsatisfactory year, especially in the Prikumok-Terek area, where the crop prospects were good but the yield of cotton was reduced two to three times as a result of the very dry and hot August and very strong, dry, and hot eastern winds.

Later it became an established practice in the Soviet Union to belittle the limitations imposed on cotton growing by the shortage of moisture. G. Morozov (*15, p. 51*) insisted that "in the unirrigated areas cotton is the most drought-resistant crop." Even if the drought resistance of cotton were greater than that of millet, the most drought-resistant crop in that part of Russia, cotton, a crop with a large input of labor before harvesting, cannot be considered well adapted to conditions where both a hot and dry and a cool and rainy summer lead to crop failures.

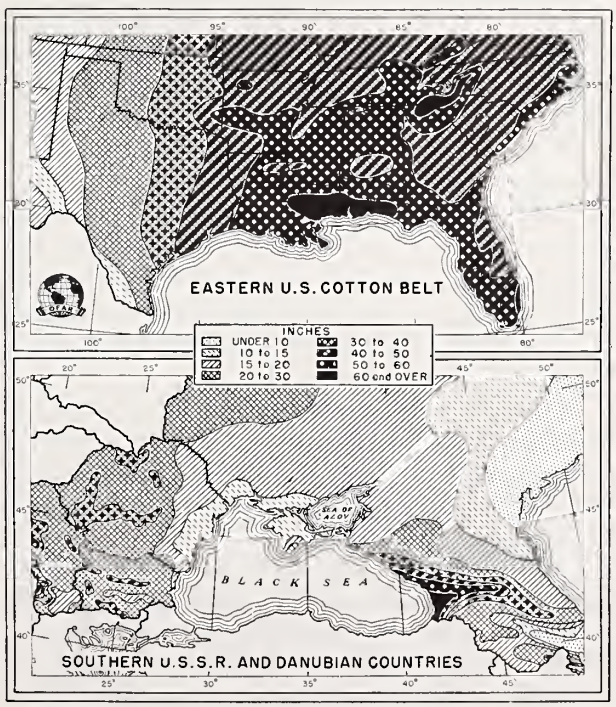


FIGURE 3.—Annual precipitation in eastern Cotton Belt of the United States and the unirrigated cotton areas of southern U. S. S. R. and the Danubian countries.

A specific adverse effect of the scarcity of moisture is that on the average it delays rather than speeds up the maturity of the cotton plant. According to the official publication *Cotton Growing in USSR* (*27, p. 41*), No. 1306, the variety almost exclusively grown in the new cotton areas, reaches maturity in from 105 to 127 days in the irrigated areas and in 118 to 164 days in the unirrigated areas of the Russian Socialist Federated Soviet Republic and the Ukraine. While the Russian irrigated cotton areas are hotter than the unirrigated, insufficient moisture early in the season and severe droughts later in the season also have a part in the delayed maturity of unirrigated cotton.[3]

## Temperatures

Cotton is not satisfied with merely so many frost-free days as, for example, the common small grains are. Like that of corn and many other plants, the adaptation of cotton to conditions farther north consisted mainly in the shortening of the growing season and, correspondingly, the total amount of warmth during the growing season rather than in lowering the rather high minimum temperatures at which the seed germinates and the plant proceeds to develop.

The general belief is that the optimum temperature of the soil for rapid germination of the cotton seed is from 60° to 65° F. (16° to 19° C.) and that the cotton plant does not make any significant progress at temperatures materially below 60° F. (15.8° C.). Only the period with temperatures of 15° C., equivalent to 59° F., and higher can be considered the growing season of cotton. Moreover, all cotton bolls do not mature at once. Hence, for cotton, part of the bolls of which mature in, say, 125 to 130 days, a total growing season of perhaps 175 to 180 days is the minimum needed to assure a satisfactory crop.

From 175 to 180 days with a minimum temperature of 15° C. (59° F.), or above, will normally have at least 4,000° C. (12,880° F.) of total warmth, and this amount is generally considered the minimum for successful cotton growing.

The closer to the minimum of required warmth the larger is the percentage of bolls which do not fully mature before the first killing frost. Another important drawback of the limited supply of warmth is that a rather close direct correlation exists between the length of the growing season and the length of the lint, the length of the lint declining rather rapidly as the season becomes shorter. The earliest varieties of cotton indeed produce only short-staple lint.

The closer an area is to the northern limit of cotton penetration the more limited is the proportion of the land which can profitably produce cotton. All operations on this crop in these areas have to be performed on time, almost to the hour, and this is possible only when the proportion of the land in this crop is small. This limitation is particularly great in Bulgaria and Yugoslavia, because cotton is grown mainly in valleys surrounded by mountains, and the total acreage which can be potentially used for cotton is anyway small.

The typical cotton areas in the United States have considerably more than the required minimum of warmth (fig. 4). Shreveport, La., and Vicksburg, Miss., average 233 to 237 days with 15° C. (59° F.), or more, and have a total of 5,400° C. for those days. Memphis, Tenn., has slightly more than 200 days and a total of 4,600° C.; Oklahoma City, 192 days and 4,300° C. St. Louis, Mo., with 174 days and 3,900° C., is slightly beyond the border line.[4]

There is apparently no place in Bulgaria that has fully 4,000° C. in days with 15°, or more, but the lowlands of southern Bulgaria are not much below this minimum. Petrich, one of the hottest spots, has 166 days with 15°, or more, and a total warmth of 3,500° C. in those days (*25*).[5] The fact that a considerable number of days, namely 57, have 10° to 15° C. also somewhat helps cotton growing in that area. The situation in southeastern Bulgaria is only a little less favorable. Moreover, in some places, such as Haskovo, the warmth deficiency is partly compensated for by the prevailing type of soil, which becomes warm quickly. The Bulgarian counties in the Danube Valley, however, which proved unable to compete with the cotton of southwestern and southeastern sections, have only about 150 days with 15°, or more, and a total of about 3,000° C. There is, of course, no more warmth also north of the river, in Rumania, than

[3] See also Doyle, C. B. (*3, pp. 353–357*).

[4] Temperature data from *The World's Agro-Climatic Handbook* (*25*) differ slightly from those of the U. S. Weather Bureau for points in the United States, but the use of one source throughout seemed advisable.

[5] Kalaptschieff's figures (*8, p. 487*) on the total amount of warmth in the Bulgarian cotton areas are even closer to the minimum of 4,000° C. than those of the *Climatic Handbook* (*25*). According to his computation, Petrich has a total of 3,961° in days with 15° C., or more.

there is south of it, in Bulgaria, but the greater protection given cotton in Rumania overcompensates for this disadvantage.

The small Yugoslav cotton area has a growing season and temperatures similar to those of adjacent southwestern Bulgaria.

Krasnodar, to the northwest of the Caucasus Mountains; Kizlyar, to the northeast of them; and Simferopol, in the Crimea, are located in about the best sections of the new Russian cotton areas so far as warmth is concerned. According to the *Climatic Handbook*, they have 146 or 147 days with 15° C., or more, and a total of 3,000° C. in such days; that is, they are in the same category as the lowlands along the Danube in Bulgaria and Rumania. Taman, one of the better cotton areas in southern Russia, has only 140 days and 2,800°. The other areas used for unirrigated cotton in Russia have 130 to 140 days with 15° C., or more, and about 2,800° of total warmth in those days.

The limiting effect of the shortage of warmth in the new areas is so great that Chebotarev and others (*2, p. 61*) believed it necessary to stress that—

> . . . the increase in precipitation during the growing season in our droughty conditions is very useful only in the case that it is not accompanied by a lowering of temperatures.

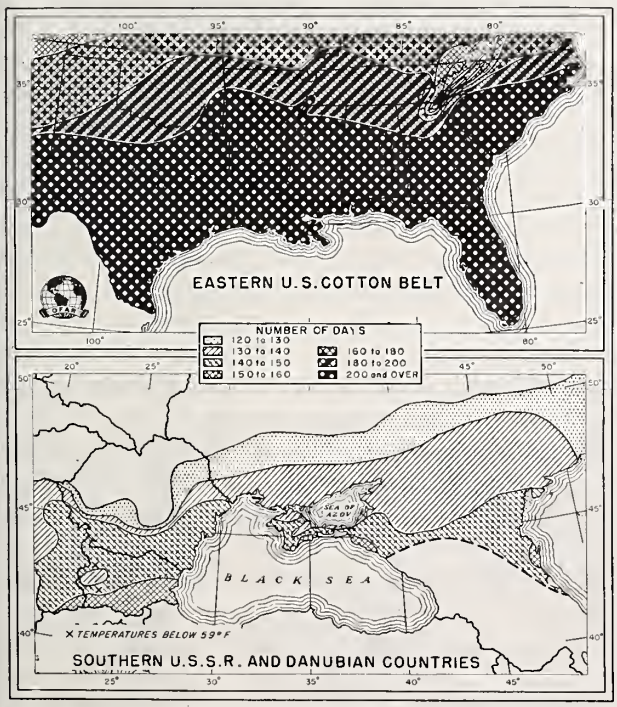


FIGURE 4.—Number of days with a temperature of 15° C. (59° F.), or above, in the eastern Cotton Belt of the United States and the unirrigated cotton areas of southern U. S. S. R. and the Danubian countries.

Rain without lowering of temperature is certainly a rather rare occurrence.[6]

## Varieties

The earliest short-staple varieties are in general grown in the areas covered by this study. Only for the warmest districts of Bulgaria are small concessions believed possible in this respect (*8, p. 496*).

Bulgaria and Yugoslavia possess domestic varieties of cotton, but they yield poorly and are also inferior in quality to imported varieties. In both countries a Bulgarian selection from a Russian variety, No. 182, is grown rather widely.[7] Among American varieties grown in Bulgaria, "Cleveland" is in greatest use. The lint of Bulgarian cotton is very short—shorter indeed than that of any cotton grown in the United States.

No. 1306, also known as "Shroeder No. 1306," is the standard variety of Russia's unirrigated cotton areas; 97.5 percent of the total was in that variety in 1939. No. 1306, a selection from the American upland variety "King," corresponds to the shortest lints of American production (*17, p. 29*); the fiber is soft but weak. The variety does not prove satisfactory for the new Russian cotton areas, the principal complaint being that it does not mature early enough. As mentioned previously, *Cotton Growing of USSR* (*27*), a publication of the advertising type, gave for No. 1306, when this is grown in the new areas, 118 to 164 as the number of days between seeding and maturity. In papers presented to a conference at the All-Russian Academy (*17, pp. 31–34*), 114 to 177 days were mentioned as the time between seeding and maturity of that variety (*13, pp. 379–380*). On a farm in Temryuk rayon, Taman Peninsula, the bolls of No. 1306 started to open in 142 days after seeding, on a 9-year average (*6, p. 16*). This is about as much as the total number of days with a temperature of 15° C., or more, in that area.

At the conference in Moscow mentioned above, it was stated (*17, p. 31*) that in the principal zones of the new cotton areas "the maturity of variety

[6] The insufficient amount of warmth as a factor precluding or greatly limiting the growing of cotton in southern European Russia was pointed out by the great cotton expert G. S. Zaitsev (*30, 29, and 4*) as early as 1928. See, furthermore, the discussion of the potentialities of cotton growing in the new Russian areas, pp. 15 and 17 of UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS, FOREIGN COTTON PRODUCTION: RUSSIA. 18 pp., illus. Washington. 1935. [Processed.]

[7] See Kalaptschieff (8. *p. 496*); also Milkovsky, Jordan D. (*14*). It is interesting that in Russia itself the use of No. 182 had been discontinued as unsatisfactory.

No. 1306 is reached only in meteorologically average and good years." In unfavorable years, such as 1933, all cotton is frost-damaged in the Ukraine, whereas in some others, as in 1928 and 1930, little cotton escapes damage (*17, p. 34*). One of the papers mentioned 1934 also as a poor year for cotton.

In all countries involved, feverish efforts have been made to develop even earlier varieties than those grown now, or, if not earlier, at least those yielding a longer lint. The experiment station at Chirpan, Bulgaria, was organized primarily with this idea in view. In Russia, several stations were working simultaneously at this task before the war. To develop a variety earlier than No. 1306 by 15 to 20 days was proclaimed the principal goal of the breeders in a paper read at the conference already mentioned. During the war, the task was assigned to the Cotton Station in Central Asia.

More than once, claims were made in Russia that the replacement for No. 1306 had been found, but more thorough tests showed the joy to be premature. A. Panov (*18*), for example, in 1940 said that No. 4943–U and No. 143–U were definitely preferable to No. 1306 for the northern portion of the Ukrainian cotton belt; that these varieties, while having lint of the same length as that of No. 1306, were earlier and more prolific. But P. Gattenberger (*5, pp. 31–32*) only a few months before mentioned No. 13,751, No. 803, No. OD–1, No. 14,958–4, and Ch–925 as most likely to replace No. 1306. The latest information [8] is that—

> it is necessary to reproduce sufficient amounts of Nos. 1306, OD–1, and especially No. 611 (the most recent, particularly early, high-yielding and long-staple variety).

No. 611 probably needs more trials before one can accept it as a full-fledged replacement for No. 1306.

As reported by Vogelsang (*28, pp. 141–142*), the Rumanian breeders were making an attempt at overcoming the handicap of an insufficient growing season by developing cotton seedlings in pots. Similar experiments were made in Russia before World War I, but the cost proved high (*12, pp. 82–83*).

## Yields

Cotton has been grown for too short a time in the areas here analyzed to permit a clear idea of the yield that may be obtained after the growers have become thoroughly familiar with this crop. In Bulgaria, average yields of lint in years for which the data may be considered significant were:

| Years | Yield | |
|---|---|---|
| | Kgs. per hectare | Lbs. per acre |
| 1924–28 | 144 | 130 |
| 1929–33 | 163 | 147 |
| 1934–38 | 191 | 172 |

The trend was definitely upward, but the increase probably cannot be explained exclusively by the increased experience of the growers. In 1934–38 many peasants grew cotton who did not do it before. The particular period seems to have been especially favorable climatically for cotton. Yields declined considerably in war years.

In Yugoslavia, lint cotton averaged 220 kilograms per hectare in 1935–39. In the preceding 6 years, the average yield, then reported in seed cotton, was only 379 kilograms, equivalent to approximately 100 pounds of lint per acre.

In Rumania, the average yield in 1935–39 was 612 kilograms per hectare of seed cotton, or, at the rate of 28 percent, 171 kilograms of lint (150 pounds per acre). Considerably less than that was harvested in the preceding and succeeding years.

Unirrigated cotton in southern Russia continued to be an almost complete failure for years (fig. 1). In 1928 through 1934, it averaged almost exactly one quintal of seed cotton per hectare, or 28 pounds of lint per acre. Most of this unsatisfactory result must be assigned to unfamiliarity with growing techniques, great shortage of draft power (and consequently of labor), and unwillingness of the growers—all these factors coming in the wake of the compulsory collectivization drive.

During the last 5 years before Russia's entrance into the war, yields in the new areas averaged 3.5 quintals of seed cotton per hectare,[9] or not quite 100 kilograms of lint per hectare (90 pounds per acre). It may be of interest to mention some of the specific information with reference to the latest prewar crops. A considerable amount of low-quality cotton was garnered in the new areas in 1937; serious adjustments were believed necessary to enable the processing plants to utilize it (*24, p. 12*). There were also many complaints by the

[8] *Socialist Agriculture*, April 2, 1946.

[9] *Socialist Agriculture*, April 2, 1946. The source does not specify the years. The actual yield was slightly less than 3.5 quintals, because the system of crop estimating was changed in 1939 to include in addition to the harvested cotton all cotton which is entirely lost under snow or otherwise.

manufacturers about the high moisture content of that cotton. Close to 20,000 metric tons (22,000 short tons), or about one-quarter of the total crop, remained unharvested in the kolkhoz fields of the Ukraine in 1938; a considerable part of it perished under snow (*19, p. 12*). In 1939, about 40,000 metric tons of cotton were snowed under in the new cotton areas (*21, p. 9*). In *Soviet Cotton* for March 1940, V. Reingardt (*20, p. 13*) even writes:

> In the whole of the RSFSR and Ukraine up to 50,000 metric tons [55,000 short tons] of cotton, or about one quintal per hectare [that is, more than one-quarter of the harvest] remained in the field. This occurs year after year.

Moreover, according to the same source, part of the harvested cotton is lost, because it is harvested wet and not dried in time.

Under the extreme conditions of southern Russia, the average yields vary substantially even in neighboring areas. A few additional warm days mean a great difference in yield. Unfortunately, sufficient data were not released to permit the computation of average cotton yields in the several unirrigated areas, but an idea of the variations may be gleaned from the planned figures, because they are based on average yields. The plan for 1937 anticipated the following yields (*11, p. 56*) in quintals of seed cotton per hectare:[10]

| | | |
|---|---|---|
| Dagestan | 4.5 | (401) |
| Odessa, Dnepropetrovsk | 4.1 | (366) |
| Azov—Black Sea | 4.0 | (357) |
| Checheno-Ingush | 3.6 | (321) |
| Ordzhonikidze | 3.3 | (294) |
| Stalingrad, Kalmyk | 3.0 | (268) |

Thus, the Stalingrad and Kalmyk Oblasts, having the smallest number of days with 15° C., or more, and also being the driest, were not expected to produce even as much as 100 pounds of lint per acre (300 kilograms of seed cotton per hectare is equivalent to about 84 pounds of lint per acre). The northern portions of Ordzhonikidze and Chechen-Ingush are not much better off. Krasnodar is best, but in the tabulation it is merged with the less favorably located Rostov Oblast.

## Growing Techniques

The shortage of the growing season being the principal handicap, every operation which speeds up maturity, such as planting on practically the first appropriate day and harvesting as soon as the bolls open, is imperative. *Cotton Growing in USSR* (*27, p. 66*) gives the following "basic elements of the technique of unirrigated cotton":

(a) Early fall plowing (September—beginning of October) to the depth of 11 to 13 inches;
(b) timely spring harrowing (in the two first days of spring work);
(c) keeping the field free from weeds and crust;
(d) timely and speedy (4 to 5 days) seeding to the depth of 1.5 to 2.5 inches;
(e) two timely hand thinnings;
(f) six timely cultivations and six hand hoeings;
(g) topping the branches and the tops in separate operations;
(h) timely harvesting.

A number of other operations are believed indispensable, such as hand-picking unripe, thin, broken, and spoiled kernels from the seed, especially if the method of speeding growth known as *yarovizatsiya* is applied; filling in the bare spots with seed or plants; hand-picking of the bollworm (*nochnaya sovka*)—not always—and picking cotton the same day the bolls open (*2, pp. 25, 35*).

While not all recommended operations are performed, the necessity of a very large input of labor, especially hand labor, in cotton growing under the adverse conditions of southern Russia, Rumania, and, to a somewhat smaller extent, Bulgaria and Yugoslavia, is beyond doubt.

## Labor Input in Bulgaria

A survey in Bulgaria, conducted by Kalaptschieff (*8, pp. 515–519*) showed the following inputs of labor per hectare (2.47 acres) of cotton:

| | Days | 10-hour days |
|---|---|---|
| Men | 33.7 | 37.3 |
| Women | 98.9 | 107.8 |
| Children | 4.8 | 4.7 |
| Total | [1] 137.4 | [1] 149.8 |

[1] One woman-day considered equal to one man-day; a child-day considered equal to 0.6 or 0.8 man-day.

These totals were composed of:

| | Days | 10-hour days |
|---|---|---|
| Preparation of the land | 21.5 | 23.8 |
| Planting to harvest | 56.0 | 69.0 |
| Harvest | 59.9 | 57.0 |

The input of draft power consisted of 85 ox-days, 11 cow-days, 2 horse-days, and 2 buffalo-days, a total of perhaps 65 horse-days per hectare.

[10] Figures in parentheses indicate pounds per acre.

The above-mentioned figures on the labor input are immense as compared with the inputs for comparable conditions in the United States. According to official computations,[11] 58 and 54 hours per acre are used on cotton in Oklahoma and Texas, respectively, or about one-tenth of the labor input in Bulgaria. The labor input is even less than that in the western parts of those States, which are the nearest approach in the United States to the natural conditions in the Danubian countries.

The labor input in cotton in Bulgaria appears in a somewhat different light if it is considered that the Bulgarian farms are small, greatly overpopulated, and employ very primitive techniques. The survey reported by Kalaptschieff covered 736 cotton fields with a total acreage of only 303.1 hectares or almost exactly one acre per field. The mere time expenditure for walking to the fields and back is necessarily large under such conditions.[12] For comparison with 134.4 labor days per hectare of cotton computed by him, Kalaptschieff quotes the data for other crops by Witanoff as follows (in days):

| | |
|---|---|
| Tobacco | 542. 0 to 794 |
| Beans | 109. 8 |
| Potatoes | 102. 6 |
| Sunflower | 102. 1 |
| Feed beets | 99. 2 |
| Corn | 75. 0 |
| Wheat | 43. 4 |
| Barley | 41. 8 |
| Oats | 29. 4 |

Thus, not quite twice as much labor is used on cotton as on corn. In Oklahoma and Texas the relation is approximately as 2 to 1. Only 3 times more work is spent on cotton than on wheat in Bulgaria as against 9 to 12 times as much in Oklahoma and Texas.[13]

## Labor Input in Soviet Russia

In Soviet Russia cotton is in a much less favorable position than in Bulgaria, so far as labor input is concerned, the competitive crops having been much more mechanized than cotton. A survey of the kolkhozy in 1937 included also kolkhozy growing unirrigated cotton in Rostov and Krasnodar Krai and Dnepropetrovsk and Odessa Oblasts (*26, pp. 16, 44–45*). By no means all the operations prescribed for cotton were performed. The farms averaged 3.74 cultivations with tractor or horse power and 3.94 hand hoeings rather than the six of each ordered. Only 53.8 percent of all cotton was topped (100 percent prescribed). In spite of this, 81.76 days of labor were spent directly per hectare of cotton (33.09 days per acre). This figure was composed of:

| | Days per hectare | Days per acre |
|---|---|---|
| Land preparation and planting | 2. 45 | 0. 99 |
| Planting to harvest | 23. 68 | 9. 58 |
| Harvest | 54. 12 | 21. 90 |
| Transport to market and others | 1. 51 | . 61 |

The stated direct labor input did not include even the labor used for the care of the working animals, not to speak of the management of the kolkhozy; the personnel of the machine-tractor stations; and so on. The yield on the investigated farms was 5.78 quintals of seed cotton (*26, p. 131*). But the average for all unirrigated cotton was only 4.5 quintals in 1937 and somewhat less than 3.5 quintals in the last prewar years. The average labor input on all farms certainly was not proportionately less than on the investigated farms. Four kilograms of seed cotton, or 2.65 pounds of the short-staple lint, per labor day is all that could have been reasonably expected from the production of unirrigated cotton in Russia's new cotton areas.

The survey of kolkhoz operations in 1937 (*26, pp. 10–16*) shows furthermore that the unirrigated cotton requires several times as much labor input as small grain, corn, and sunflower, the standard crops of the respective areas (days per hectare):

| | Rostov | Krasnodar | Dnepropetrovsk | Odessa | Simple average |
|---|---|---|---|---|---|
| Cotton | 74. 55 | 107. 41 | 65. 69 | 98. 31 | 86. 49 |
| Winter grain | 6. 82 | 7. 93 | 6. 24 | 8. 89 | 7. 47 |
| Spring grain | 6. 59 | 7. 14 | 7. 77 | 10. 15 | 7. 91 |
| Corn | 14. 87 | 12. 27 | 18. 36 | 21. 00 | 16. 63 |
| Sunflower | 10. 08 | 9. 87 | 14. 19 | 17. 66 | 12. 95 |

Thus, the relation of the labor input between cotton, on the one hand, and small grain and corn, on the other hand, in southern Russia is even less favorable for cotton than in Texas and Oklahoma. The absolute level of the additional input of labor in Russian cotton (almost 80 days per hectare more than on small grains and 70 days more than on corn and sunflower) is even more significant.

[11] Cooper, M. R., Holley, W. C., Hawthorne, H. W., and Washburn, R. S. Labor requirements for crops and livestock. U. S. Bur. Agr. Econ. F. M. 40, 140 pp. Washington. 1943. [Processed.] See p. 116.

[12] The writer is grateful to Mr. P. Egorov, who participated in similar investigations in Bulgaria, for the information that the time to and from the field is commonly included in the total in Bulgarian investigations.

[13] See pp. 5, 17, and 116 of reference cited in footnote 11.

# Economic Conditions

Two factors favor cotton production on a moderate scale in the areas here analyzed. One of them is the fact that all those areas are surplus areas in staple food. The prices of the crops competing with cotton for the land are therefore low. The second such factor is cheapness of labor in all countries involved. The cheap labor makes the extra labor input in cotton much less important there than it is, for example, in the United States.

In spite of the favorable effect of those factors on cotton growing, in none of the regions involved can cotton be grown without a rather considerable amount of protection. Cotton is about 8 times as expensive as wheat and about 10.5 times as expensive as corn in western Oklahoma and western Texas.[14] None of the regions here studied would be able to grow cotton at such price relationships.

There is a substantial difference with reference to the position and the type of protection needed by the unirrigated cotton between the Danubian countries and Russia. The Danubian countries produce only unirrigated cotton. If they want to have their own cotton, they have to go on with the production of the unirrigated commodity. The protection needed by the cotton in those countries is, hence, that against foreign cotton.

Along with the areas of unirrigated cotton, Russia has large areas of irrigated cotton, which can be properly designated as natural cotton areas. The small percentage of the total cotton output contributed by the unirrigated cotton (7 to 8 percent at best) can well be compensated for by expansion of the production of irrigated cotton. The protection needed by the Russian unirrigated cotton is in the first place against another type of domestic cotton.

## BULGARIA

After a few years of protection of domestic cotton by import duties, Bulgaria made trade in cotton a State monopoly. The producers are assured that their total output will be taken over by the State at remunerative prices fixed in advance. As a reflection of the climatic differences, the fixed price for north-Bulgarian cotton is more than 10 percent below that of south-Bulgarian cotton; the fixed price of cotton from Burgas in the east is intermediate between the two. The prices for domestic varieties are in all areas lower than those of foreign varieties.

Although cotton from western Oklahoma and Texas is a low-quality product, partly owing to the harvesting of much of the crop by the sledge, it certainly is better than Bulgarian cotton. In spite of this, the producers in Bulgaria received per quintal (220 pounds) of their cotton on the average during 1936–38, 2,999 leva [15] as against 319 and 239 leva received per quintal of wheat and corn, respectively (*1, 1939, pp. 276–277; 1940, pp. 278–279*). Thus, on the basis of comparable weights, cotton brought a return 9.4 times greater than wheat and 12.5 times greater than corn. The average returns per hectare for the same years were as follows (*1*):

| | *Leva* |
|---|---|
| Cotton | 5,490 |
| Wheat | 4,521 |
| Corn | 2,470 |

Labor being very cheap in Bulgaria, the additional return for cotton should amply suffice to compensate the producers for the extra input of labor and power.

## RUMANIA

The encouragement granted to cotton in Rumania has been even greater than in Bulgaria, and the Rumanian cotton needed the extra help. The cotton-spinning mills are required to take over the ginned cotton at a rather stiff price set in advance. In addition, the growers have a claim for a substantial reduction in taxes, for duty-free imports of equipment, and so on. The large amount of protection granted to the Rumanian cotton is obvious from the following figures (in Rumanian lei [16]) pertaining to the 1937 crop (*23, p. 424*):

| | Price (per quintal) | Return (per hectare) |
|---|---|---|
| Seed cotton | 1,700 | 12,615 |
| Wheat | 459 | 4,889 |
| Corn | 267 | 2,443 |

Consequently, seed cotton was about 3.7 times more expensive than wheat and 6.9 times more expensive than corn. The return per acre of cotton was 2.6 and 5.2 times larger, respectively. With an extraction of lint of 28 percent and the value of the seed and the cost of ginning ignored, lint in

[14] GANS, A. R., AND HALE, R. F. REGIONAL VARIATIONS IN PRICES RECEIVED BY FARMERS, 1925–34, FOR 10 SELECTED COMMODITIES. (U. S. Farm Credit Adm. in Cooperation with U. S. Bur. Agr. Econ.) 21 pp., illus. Washington. 1939. [Processed.] See pp. 3, 5, and 9.

[15] The value of the lev, in U. S. currency, according to official exchange rates, averaged about 1.3 cents during 1936–38.

[16] In 1937, the leu was worth about 0.73 U. S. cent.

Rumania was 13 times (6,070 lei) more expensive than wheat (459 lei) and 21.6 times more expensive than corn (276 lei), and in Bulgaria lint was about 10 times more expensive than wheat and 12.5 times more expensive than corn.

SOVIET RUSSIA

The idea was immediately recognized in the Soviet Union when a decision was made to initiate the growing of unirrigated cotton in southern Russia that this cotton could not compete with the irrigated cotton of Central Asia (*7, pp. 255–256*). In the last prewar years the prices paid for seed cotton of the unirrigated areas were 30 to 40 percent higher than for seed cotton of Central Asia. The highest premium was for the three lowest grades, prices of which were of greater interest to the unirrigated than to the irrigated areas. Since prices are fixed for seed cotton in Russia, the producers of the unirrigated areas are not penalized for the shortness of the lint which is obtained from their cotton. However, they do get somewhat less for their cotton than is indicated by the above-mentioned price relationship, because a larger percentage of their cotton falls into the lower grades than is the case in Central Asia.

An additional advantage to the growers of unirrigated cotton in the Soviet Union is that the charge for the services of State machine-tractor stations, which are practically obligatory, is almost nominal to them. In recent prewar years, the growers of unirrigated cotton paid for the same operations only about one-tenth as much as the average growers of irrigated cotton (*10, p. 461*). This reduction in the charge of the machine-tractor stations was equivalent to an extra premium for unirrigated cotton of about 13 percent of the price of Central Asiatic cotton.

The following information[17] was released on the cost of producing raw cotton on State farms in rubles per quintal (220 lbs.):

| | 1933 | 1938 |
|---|---|---|
| Unirrigated | 398. 0 | 151. 2 |
| Irrigated | 149. 0 | 113. 6 |

The plans for the growing of unirrigated cotton, as of practically any other cotton, were and remain compulsory for the growers. This makes it impossible to say whether the additional advantages to the growers of this cotton sufficed to compensate for the low yields in normal years and the frequent crop failures in poor years. If the compulsion were removed, possibly all or most of the unirrigated cotton would disappear almost overnight.

## Conclusion

The fact that the Fourth Five-year Plan cut the goal for unirrigated cotton from 508,000 hectares (1,255,000 acres) provided by the Third Plan for 1942 to 168,000 hectares (416,000 acres) in 1950 did not come as a surprise. The immense losses in human life in the war and the great need for labor for repairing the war damage made it unlikely that the Soviet Government would persist in the growing of a crop which returns so little per day of work as does the unirrigated cotton of southern Russia.

One can be reasonably certain that, unless real progress is made in breeding considerably earlier varieties than No. 1306, the large cut in the goal of the Fourth Plan will prove only the beginning of the abandonment of the fight against nature, a fight which was started from the wrong end.[18] In our time the breeder rather than the grower has to lead the way in expanding the climatic border lines of the various crops.

The climatic conditions for the growing of cotton are almost as unfavorable in Rumania as in southern Russia. But Rumania may not be in a position to utilize effectively its surplus of rural population for the development of industry and might therefore hesitate to abandon fully the otherwise unprofitable crop.

Southern Bulgaria and southernmost Yugoslavia, among the countries here studied, are relatively in the best position with reference to cotton. A moderate success of breeders in developing even earlier varieties would move the line of cotton penetration north of all or most of those areas. The large overpopulation, for which no real relief is in prospect, will favor cotton. The necessity of having a large amount of labor available at any moment that it is needed for cotton will be an important limiting factor. With a considerable amount of protection, Bulgarian agriculture may possibly cover all the needs of the country for short-staple cotton; Yugoslavia is unlikely to at-

[17] G. Morozov (*16, p. 112*). The rubles cannot be converted to American currency, but the prices seem to be usable for purposes of this discussion.

[18] In the paper of the Ministry of Agriculture (*Socialist Agriculture,* April 2, 1946), a person in a responsible position speaks of the reduced goal for unirrigated cotton as a temporary measure only. But this may be face-saving.

tain even this. From the point of view of world markets, the production of both countries cannot attain real significance.

# Literature Cited


(1) [Bulgaria] Direction Générale de la Statistique.
1939–40. annuaire statistique du royaume de bulgarie, 1939 and 1940. Sofia.

(2) Chebotarev, I., Abolin, Ya., and Kozhukhovsky, L.
1938. [cotton in rostov province.] 82 pp., illus. Rostov. [In Russian.]

(3) Doyle, C. B.
1941. climate and cotton. U. S. Dept. Agr. Yearbook. 1941: 348–363.

(4) Fedorov, E. E.
1928. note on g. s. zaitzev's paper "on new cotton areas." Ann. State Inst. Exp. Agron. 6 (5–6): 9–23, illus. [In Russian, with English table of contents; also English résumé p. 23.]

(5) Gattenberger, P.
1939. [substitute cotton variety 1306 with better varieties.] Soviet Cotton 1939 (11–12): 29–32, illus. [In Russian.]

(6) Jachtenberg, P. A.
1937. [cotton growing in the azov-black sea. krai.] 100 pp., illus. Rostov-Don. [In Russian.]

(7) Kaktyn, A. M., ed.
1934. [socialist reconstruction of cotton growing.] 287 pp., illus. Moscow and Leningrad. [In Russian.]

(8) Kalaptschieff, Georgi D.
1940. untersuchungen über die natürlichen und wirtschaftlichen bedingungen und die aussichten des baumwollbaues in bulgarien. [Germany] Reichs Min. f. Ernähr. u. Landw. Ber. über Landw., Bd. 24, Heft 3, pp. [477]–548, illus.

(9) Karper, R. E., and Jones, D. L.
1927. varieties of cotton in northwest texas. Texas Agr. Expt. Sta. Bul. 364. 59 pp., illus.

(10) Kilosanidze, V. V., comp.
1935. [model contract between machine-tractor stations and kolkozy, approved february 17, 1934.] *In* [Most Important Regulations Pertaining to Agriculture.] Ed. 2, 776 pp., illus. Moscow. [In Russian.]

(11) Markovich, M.
1937. [contract buying and procurements of cotton.] 57 pp., illus. Moscow. [In Russian.]

(12) Melkich, Alexander.
1933. stand und aussichten des baumwollbaus in der sovet-union. [Germany] Reichs Min. f. Ernähr. u. Landw. Ber. über Landw., Sonderheft 82, 109 pp., illus.

(13) Michael, Louis G.
1938. cotton growing in the soviet union. Foreign Agr. 2: [353]–382, illus.

(14) Milkovsky, Jordan D.
1938. die neuen baumwollsorten auf der tschirpaner versuchstation. Spis. Zeml. Izp. Inst. B''lgariia (Rev. Insts. de Rech. Agron. en Bulgarie), Heft 2, 8: [87]–116, illus. [In Bulgarian; German résumé, pp. 115–116.]

(15) Morozov, G.
1939. [the reserves of soviet cotton growing.] Socialist Agr. No. 11, 1939: 48–54. [In Russian.]

(16) ———
1939. [toward new victories of soviet cotton growing.] Socialist Agr. No. 1, 1939: 110–119. [In Russian.]

(17) Nikitin, I., ed.
1936. breeding work, genetics and physiology of cotton. (Materials of Conf. All-Union Lenin Acad. Agr. Cien., Jan. 2–6, 1935.) Issue 43, 109 pp., illus. Moscow. [In Russian, with English title page.]

(18) Panov, A.
1940. [early ripening varieties of cotton in northern districts of ukrainian s. s. r.] Soviet Cotton 1940 (10): 28–32. [In Russian.]

(19) Reingardt, V.
1939. [harvest the cotton in the new districts on time.] Soviet Cotton 1939 (9): 12–15. [In Russian.]

(20) ———
1940. [ten years of cotton sowing in the new areas and the immediate tasks.] Soviet Cotton 1940 (3): 11–16. [In Russian.]

(21) ———
1940. [the organization of cotton harvesting in the new areas.] Soviet Cotton 1940 (9): 9–14, illus. [In Russian.]

(22) Rogozhin, N., and Kupriyanov, I.
1931. [the new cotton areas.] 139 pp., illus. Leningrad and Moscow. [In Russian.]

(23) [Rumania] Institutul Central de Statistica.
1939. anuarul statistic al României, 1937 and 1938. 713 pp., illus. Bucuresti.

(24) Shestakov, V. I.
1938. [the tasks of light industry in 1938.] Light Indus. 17 (3): 9–18. [In Russian.]

(25) [U. S. S. R. Agro-Hydrometeorological Institute.]
1937. [the world's agro-climatic handbook.] 411 pp., illus. Leningrad and Moscow. [In Russian.]

(26) [U. S. S. R. Central Statistical Office of the Gosplan.]
1939. [productivity and utilization of labor in kolkhozy in the second-plan period.] 140 pp., illus. Moscow. [In Russian.]

(27) [U. S. S. R. Commissariat of Agriculture.]
1940. [cotton growing in ussr.] 111 pp., illus. Moscow. [In Russian.]

(28) Vogelsang, Walter.
[1935.] die textilindustrie grossrumäniens. Wiener Geog. Studien, 200 pp., illus. Wien.
(29) Zaitzev, G. S.
1928. my reply to e. e. fedorov. Ann. State Inst. Exp. Agron. 6 (5–6) : 152–154. [In Russian, with English table of contents.]
(30) Zaitzev, G. S.
1928. on new cotton areas. Ann. State Inst. Exp. Agron. 6 (2) : 9–15, illus. [In Russian, with English table of contents.]

Editor's Note.—Translations of Russian titles as listed above were made in this Office.

# Trends in Brazilian Agriculture

*by* **KENNETH WERNIMONT***

**Brazil occupies a big corner in the Americas. Its land area is larger than that of the United States, and its agricultural and forest resources annually contribute a substantial part of the exports from countries "south of the border." A bird's-eye view of recent developments in the agriculture of this vast country is therefore of interest as the world turns from wartime problems to peaceful occupations.**

Roughly, a third of the population of Latin America is Brazilian. This population, now estimated at 45,000,000, is predominantly agricultural with two-thirds of the people living on the land. The economy of the country, although currently undergoing a form of industrial revolution, still depends basically on raw materials derived from field and forest. Four-fifths of the tonnage and three-quarters of the value of the country's exports in 1945 were of agricultural or forest origin, mostly in unprocessed or semiprocessed state.

One of the developments of recent years which is having widespread repercussions is the fact that livestock raising has become the number-one agricultural industry from the point of view of income to farmers. This fact has tended to shift emphasis away from the traditional coffee interests. Nevertheless, coffee remains the country's most important agricultural export commodity.

While the land area of Brazil is larger than that of continental United States, a major portion of it is characterized by poor soils lacking in organic matter and essential minerals. Moreover, the best lands available to coastal cities and marketing centers have already been depleted by generations of cropping with sugar, coffee, and, more recently, cotton and other products. Even the fine grazing lands of Rio Grande do Sul are beginning to show signs of overgrazing after 400 years of settlement.

The steadily rising cost of living during the war years has exceeded increases in wages for both rural and urban workers, thereby bringing the problems of food supply into sharp public focus. The Government has taken steps to solve the food problem, first, through widely publicized programs for increased production, and, second, through the control of exports.

The Government program for increased production of foodstuffs has emphasized the mechanization of agriculture, strengthening of production credit, and improvement in the distribution system through construction of storage and refrigeration facilities at strategic points in the interior, as well as through the improvement of roads.

Figure 1.—Coffee—Brazil's leading export crop.

*Agricultural Commissioner, American Embassy, Rio de Janeiro, Brazil.

Export-control measures have come into special prominence since the early months of 1946. Brazil's normal supply of foodstuffs is barely adequate to feed the population. During the 1946 season there have been no real surpluses of food in Brazil, with the exception of rice, beans, and corn. Comparatively little of the surplus corn has reached world markets because of lack of facilities for fumigation and shipment. The wheat shortage in 1946 upset all early calculations of food surpluses in Brazil. Instead of the usual 100,000 to 120,000 metric tons (110,000 to 132,000 short tons) of wheat normally imported from Argentina each month, imports of wheat and wheat equivalent of flour from all countries during the 1946 calendar year averaged between 35,000 and 40,000 metric tons (38,600 and 44,000 short tons) per month. This has necessitated much more widespread domestic consumption of rice, corn, and starchy root crops than was originally anticipated.

In looking forward to what is ahead for Brazilian agriculture, it is apparent that a search for new frontiers will be a major consideration in the struggle to feed, clothe, and house the rapidly increasing Brazilian population. Some of these frontiers are to be found in the areas of relatively good land still available in Goiaz, northwestern São Paulo, northern Paraná, and in other scattered locations from 500 to 2,000 miles inland. Settlers from older areas in Brazil are already pouring into the more accessible sections of these lands. With this movement of settlers, the much-needed development of highways and distribution facilities for agricultural products must follow within a period of 5 to 10 years.

Another large area of possibility for settlement on new lands is to be found in the São Francisco Valley in the "bulge" region of the Northeast. For the past several years the Brazilian Government has been studying a project for developing hydroelectric power at Paulo Affonso waterfall several hundred miles from the mouth of the river.

Other new frontiers for the Brazilian people lie well within the range of the coastal fringe of settlement. A program of far-reaching implications during the war years has been the health and sanitation work carried out under a cooperative agreement between the United States and Brazilian Governments. Malaria control and other sanitation measures have achieved a remarkable degree of success in the face of almost insurmountable difficulties in the Amazon Valley, in the vicinity of the quartz-crystal mines in the interior of Baía and Goiaz, and in the valley of the Rio Doce, which flows from eastern Minas Gerais through the State of Espírito Santo and into the Atlantic Ocean.

Another important frontier for the Brazilian agricultural population may be opened by more widespread application of fertilizers. To date, most of Brazil's phosphates have been imported, but there is a small phosphate production in the State of São Paulo, and other possibilities in northeast Brazil are being studied for the future. Up to this point in the history of Brazilian agriculture, comparatively little attention has been given to the application of fertilizers, because it has been possible heretofore to move from depleted areas to new lands. There is now reason to believe that insufficient undeveloped good land remains to make-up for the ever-increasing population rate.

Many improvements in Brazilian agriculture can be anticipated during the next few years as a result of the recent stress on the mechanization of agriculture. Successful mechanization is now possible for the first time in Brazil, owing in large part to the fact that the prices of agricultural products on domestic markets have at last risen to levels which permit the economic use of machinery. Perhaps an even more important factor is that the supply of farm labor has become relatively scarce and wages relatively high; consequently, employers are being forced to mechanize their operations.

Along with mechanization, there is an increasing emphasis upon development of new cropping methods, including variety selections, diversification of crops, soil conservation, and other measures. A favorable indication of Brazil's continued importance in the world agricultural economy is the attention being given to special crops. Statements issued by responsible Government officials have stressed the importance of increasing the production of foodstuffs, but, at the same time, they have

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strongly indicated that these increases must be accomplished by a real expansion of agriculture. Larger and better quality production of vegetable-oil, insecticidal, and fiber crops, including cotton, have been called for in addition to adequate foodstuffs production.

Symbolic of the future of Brazilian agriculture is the new Federal Center for Agricultural Education and Research at Kilometer 47 on the Rio de Janeiro-São Paulo highway. Visitors to this institution, which will be ready for opening sometime in 1947, are generally impressed with the fact that it is laid out in a grand manner with a series of monumental buildings.

The objective of the institution; namely, to bring agricultural teaching and agricultural research together in a common environment, is exceptionally valuable. Many of the research institutes of the Government, such as the Vegetable Oil Institute, the Chemical Institute, and the Agricultural Experiment Station, will have adequate space and equipment to carry on their work for the first time since they were created some years ago. Moreover, the experimental fields, which include some 10 square miles of land, are located in an area of inferior soils so that the experimental work must be on a sound basis to show results. Some of the more far-seeing Brazilian technicians are beginning to recognize that their findings at Kilometer 47 will have added value for Brazil for this very reason.

One great uncertainty with regard to the future of Brazilian agriculture arises from the dearth of technicians trained in practical agriculture. This shortcoming is being met in some degree in recent years by the sending of numerous fellowship and scholarship candidates to the United States for training, and the situation may be further improved within the next 2 or 3 years by the extensive program of the American Educational Foundation. This organization is just now starting its program which involves a combination of Brazilian and North American funds specifically allotted to the training of agricultural workers at a level somewhat below the so-called technician.

In summing up, one should note that Brazil's 45 million people have done remarkably well over a period of years with the scattered resources available. With modern scientific developments, substantial progress may be expected in the future. The speed of this progress will be gaged in part by the character and ability of the leaders of the country, and it will certainly be dependent upon world trade policies laid down for the postwar era by the United States and other leading foreign countries operating in the Western Hemisphere.

FIGURE 2.—In the mountains between São Paulo and Minas Gerais old coffee lands have been planted to general crops.

U. S. GOVERNMENT PRINTING OFFICE: 1945